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Body-Worn Spiral Monopole Antenna for On-Body Communications

(*Invited Paper*)

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Abstract

A novel body-worn spiral monopole antenna is presented. The antenna consists of a ground plane and a spiral monopole. The antenna was designed for Ear-to-Ear (E2E) communication between In-the-Ear (ITE) hearing instruments at 2.45 GHz and has been simulated, prototyped, and measured. The antenna yielded a measured and simulated E2E path gain at 2.45 GHz of –82.1 dB and –85.9 dB, respectively. The radiation pattern of the antenna when mounted in the ear is presented and discussed.

Key Words: Body-Centric Communication, Creeping Waves, In-the-Ear Hearing Instruments Antenna, On-Body Path Gain, WBAN.

I. INTRODUCTION

Body-worn antenna research for body-centric communication has increased over the last decade. Ever smaller electronics have enabled a wide range of new applications where wireless communication can be implemented. Many of these new applications have been developed for medical devices, such as hearing instruments (HIs). There is considerable interest within the HI industry in obtaining Ear-to-Ear (E2E) communication between HIs. An E2E link improves the acoustic performance of HIs as well as the usability. Besides E2E communication there is an interest in communication with both on- and off-body accessories, for example smartphones, smart watches, or TVs. By the use of the license-free and worldwide industrial, scientific, and medical (ISM) band between 2.40 GHz and 2.48 GHz both E2E and accessory communication can be obtained. At the same time it will enable communication with electronics with Bluetooth. Antennas suitable for Behind-the-Ear (BTE) HIs have been presented in the literature with an E2E path gain of –52 dB [1]. BTE HIs are located behind the ear and are mass produced whereas In-the-Ear (ITE) HIs are placed in or right outside the ear canal and are custom-made to fit the user's ear and ear canal. This makes it harder to achieve a high E2E path gain for ITE HIs. The ITE antennas that have been presented in the literature have not yielded E2E path gains significantly above –90 dB [2, 3]. In the following a novel ITE antenna, which is the first to make E2E communication feasible between ITE HIs is presented. The antenna was first presented briefly in [4]. This is an augmentation of the article presented in [5].

II. THEORY

At 2.45 GHz, the human body is very lossy [6]. Therefore, the electromagnetic energy cannot propagate through the body. It has been shown that the electromagnetic energy propagates around the human body as creeping waves instead [7]. Models for the E2E propagation channel have been presented in [8, 9].

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